SHIELDALLOY METALLURGICAL CORPORATION

12 WEST BOULEVARD
P.O. BOX 768
NEWFIELD, NJ 08344-0768
TELEPHONE (856) 692-4200

DAVID R. SMITH
ENVIRONMENTAL MANAGER
Aluminum Products & Powders Division

September 9, 1999

Mr. Theodore S. Sherr, Chief
Chief, Licensing and International Safeguards Branch
Division of Fuel Cycle Safety and Safeguards, NMSS
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: Application to Amend Source Material License No. SMB-743

Dear Mr. Sherr:

Shieldalloy Metallurgical Corporation (SMC) wishes to replace the Annual Limit on Intake (ALI) and Derived Air Concentration (DAC) for Y-class thorium and uranium compounds that appear in Appendix B of 10 CFR 20 with those derived using the 1995 recommendations of the International Commission on Radiological Protection (ICRP).[1] Included herein is a brief discussion of why the 10 CFR 20 Appendix B DACs and ALIs are inappropriate for use at SMC, adjusted DACs and ALIs for SMC and a description of how they were derived using the new ICRP recommendations, and a plan for incorporating the adjusted values into SMC's radiation safety program.

Statement of the Problem

The DAC for ^{232}Th shown in Appendix B of 10 CFR 20 is based upon the 1977 recommendations of the ICRP as they appear in Publication 30.[2] In those recommendations, a number of highly conservative assumptions were made in order to simplify the calculations for dose limitation. One assumption that significantly influenced the apparent dosimetric significance of ^{232}Th was that all Y-class (i.e., insoluble) compounds, such as thorium dioxide, were assumed to clear from the lungs with a half-time of only 500 days.[3] This assumption esulted in what appeared to be a large fraction of inhaled Y-class material translocated to the bone surfaces. It was then assumed to be retained there for a biological half-time of 8,000 days.

The model used in the 1977 recommendations of the ICRP does not reflect the realistic metabolism of thorium dioxide compounds, and implies a dose to the bone surfaces per unit intake of ^{232}Th that is unreasonably and inappropriately high. More recent and more applicable scientific data demonstrate something completely different . . . that Y-class ^{232}Th is tenaciously retained in the lung with a clearance half-time that is greatly in

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[1]International Commission on Radiological Protection, ICRP Publication 68, "Dose Coefficients for Intakes of Radionuclides by Workers - Replacement of ICRP Publication 61", Pergamon Press, 1995.

[2]International Commission on Radiological Protection, ICRP Publication 30, "Limits for Intakes of Radionuclides by Workers", Pergamon Press, 1977.

[3]A similar assumption was made for ^{238}U. However, the focus of this license amendment application is on ^{232}Th.

excess of 500 days. In addition, the newer metabolic information demonstrates that there is significantly lower translocation of inhaled material to the bone.[4,5,6,7]

This change in scientific thinking was recognized by the ICRP and thus incorporated into its 1995 recommendations. These recommendations, which appear in ICRP Publications 67 through 72, include a comprehensive description of an updated biokinetic model for ^{232}Th, and a listing of inhalation dose coefficients that are intended to replace those recommended in 1977.[8]

Derivation of the Proposed DAC

SMC wishes to replace the DACs and ALIs for ^{232}Th shown in Appendix B of 10 CFR 20 with those derived using the 1995 recommendations of the ICRP. The derived values are shown in Attachment 1. In addition, and to ensure uniformity in implementation, we also wish to replace the Appendix B ALIs and DACs for ^{238}U with those that are also shown in Attachment.

For your information, the ALIs shown in Attachment 1 were calculated as follows:

$$ALI\ (Bq) = \frac{D_L}{DCF}$$

where D_L = the applicable dose limit (0.05 Sv CEDE or 0.5 Sv CDE, as appropriate), and DCF = the applicable dose conversion factor (tissue or effective), in units of Sv/Bq. S-class ^{232}Th or ^{238}U with a one (1) μm (AMAD) particle size, was assumed in all cases. and the specific tissues at risk were taken from ICRP 71.[9] The DCFs in ICRP 71 were derived using the same internal dosimetry models described in ICRP Publication 68.[10,11]

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[4]Rundo, J., Brewster, D. R., Essling, M. A., Sha, J. Y., "Radioactivity in former workers at a thorium refinery" in *Actinides in Man and Animals, Proc. Snowbird Actinide Workshop* (ed. by M. E. Wrenn), R. D. Press, Salt Lake City, Utah, 1981.

[5]Newton, D., Rundo, J. Eakins, J.D., "Long term retention of ^{228}Th following accidental intake", *Health Physics* 40, 1981.

[6]Mausner, L.F., "Inhalation Exposures at a Thorium Refiner", *Health Physics* 42, 1982.

[7]Singh, N. P., and M. E. Wrenn, "Plutonium concentration in human tissues: Comparison to thorium", *Health Physics* Vol. 44, 1983.

[8]The new dose coefficients appear in ICRP Report No. 71, "Age-dependent doses to Members of the Public from Intake of Radionuclides: Part 4 Inhalation Dose Coefficients", 1995.

[9]In its recent recommendations, the ICRP ceases to classify insoluble materials as Y-class, as they did in their 1977 recommendations. Instead, compounds like thorium dioxide, fall into what is now known as S-class, meaning that, upon inhalation, they clear from the lung "slowly".

[10]International Commission on Radiological Protection, ICRP Publication 71, "Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 4 Inhalation Dose Coefficients", Pergamon Press, 1995, Table 5.26.4(c), pg. 293.

[11]Even though the calculational methodology for the ICRP 68 and ICRP 71 DCFs is the same, the DCF for effective dose in ICRP 71 is slightly higher than ICRP 68 (i.e. 2.5e-5 vs. 2.3e-5 Sv/Bq). This is likely attributed to

The DAC is defined as the concentration of a radionuclide in air which, if breathed by Reference Man over a working year of 2000 hours under conditions of "light activity" (i.e., 1.2 m^3 per hour), would result in an intake equivalent to the applicable occupational dose limit for inhalation. Therefore, the DACs for ^{232}Th and ^{238}U that appear in Attachment 1 were determined as follows:

$$DAC\ (\frac{Bq}{m^3}) = \frac{ALI}{Vol.\ Air}$$

Because Attachment 1 shows the limiting dose to be to the bone surfaces in the case of thorium, and to the lung in the case of uranium, non-stochastic DACs and ALIs are applicable. Therefore, SMC is requesting that the DAC_{NS} and the ALI_{NS} for the ^{232}Th in our feed, slag, baghouse dust, and other source material items be adjusted to 1.9×10^{-11} μCi/ml and 4.7×10^{-2} μCi, respectively. We are also requesting an adjusted DAC and ALI for ^{238}U of 8.4×10^{-11} μCi/ml and 2.0×10^{-1} μCi, respectively.

Action Plan

Upon USNRC approval of this application, SMC intends to incorporate the aforementioned adjusted DACs and ALIs for ^{232}Th and ^{238}U into its routine internal exposure control procedures as described in the SMC "Radiation Protection Program Plan". Shortly thereafter, SMC will re-evaluate the technical basis of this and related procedures in light of the DAC/ALI adjustment to ensure their continued applicability. As necessary, revisions will be made.

In an April 21, 1999 memorandum, the USNRC indicated that exemption requests such as the one contained herein would be approved on a "case by case" basis.[12,13] Therefore, SMC is hopeful for a timely and favorable response to this important license amendment application. Please call me at (609) 692-4200, extension 226 if I can answer any questions, or provide you with any additional information necessary to facilitate your review.

Sincerely,

David R. Smith
Radiation Safety Officer

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the inclusion of an age dependency factor in the ICRP 71 values, and/or round-off error.

[12]Memorandum from Vietti-Cook, A. to W. D. Travers, "Staff Requirements - SECY-99-077 - to Request Commission Approval to Grant Exemptions from Portions of 10 CFR Part 20", U. S. Nuclear Regulatory Commission, April 21, 1999.

[13]U. S. Nuclear Regulatory Commission Policy Issue, SECY-99-077, "To Request Commission Approval to Grant Exemptions from Portions of 10 CFR Part 20", March 12, 1999.

cc: Nigel C. Morrison
James P. Valenti
Hugo L. Nieves
Lidia M. Stasiuk
Steve Danilak
Paul A. Gonzales
Ellen Harmon, Esq.- Metallurg
Carol D. Berger - IEM
Edward Shum - USNRC Licensing Section 2
Marie Miller - USNRC Region 1

ATTACHMENT
LISTING OF DACs AND ALIs
(S-Class, 1 μm AMAD Particle Size)

Tissue at Risk	Th-232						U-238				
	D_L (Sv)	DCF (Sv/Bq)	ALI		DAC		DCF (Sv/Bq)	ALI		DAC	
			Bq	μCi	(Bq/m³)	μCi/ml		Bq	μCi	(Bq/m³)	μCi/ml
Gonads (testes)	0.5	2.6e-06	1.9e+05	5.2e+00	8.0e+01	2.2e-09	1.5e-08	3.3e+07	9.0e+02	1.4e+04	3.8e-07
Bone marrow	0.5	1.2e-05	4.2e+04	1.1e+00	1.7e+01	4.7e-10	4.9e-08	1.0e+07	2.8e+02	4.3e+03	1.1e-07
Colon	0.5	9.0e-07	5.6e+05	1.5e+01	2.3e+02	6.3e-09	2.6e-08	1.9e+07	5.2e+02	8.0e+03	2.2e-07
Lungs	0.5	1.6e-04	3.1e+03	8.4e-02	1.3e+00	3.5e-11	6.7e-05	***7.5e+03***	***2.0e-01***	***3.1e+00***	***8.4e-11***
Stomach wall	0.5	8.2e-07	6.1e+05	1.6e+01	2.5e+02	6.9e-09	1.5e-08	3.3e+07	9.0e+02	1.4e+04	3.8e-07
Bladder wall	0.5	8.2e-07	6.1e+05	1.6e+01	2.5e+02	6.9e-09	1.5e-08	3.3e+07	9.0e+02	1.4e+04	3.8e-07
Breast	0.5	8.3e-07	6.0e+05	1.6e+01	2.5e+02	6.8e-09	1.5e-08	3.3e+07	9.0e+02	1.4e+04	3.8e-07
Liver	0.5	5.1e-06	9.8e+04	2.7e+00	4.1e+01	1.1e-09	6.2e-08	8.1e+06	2.2e+02	3.4e+03	9.1e-08
Esophagus	0.5	8.3e-07	6.0e+05	1.6e+01	2.5e+02	6.8e-09	1.5e-08	3.3e+07	9.0e+02	1.4e+04	3.8e-07
Thyroid	0.5	8.2e-07	6.1e+05	1.6e+01	2.5e+02	6.9e-09	1.5e-08	3.3e+07	9.0e+02	1.4e+04	3.8e-07
Bone Surfaces	0.5	2.9e-04	***1.7e+03***	***4.7e-02***	***7.2e-01***	***1.9e-11***	4.6e-07	1.1e+06	2.9e+01	4.5e+02	1.2e-08
Effective	0.05	2.5e-05	2.0e+03	5.4e-02	8.3e-01	2.3e-11	8.0e-06	6.3e+03	1.7e-01	2.6e+00	7.0e-11

Values shown in ***italics*** are the most limiting.